N o r t h e a s t e r n F o r e s t E x p e r i m e n t S t a t i o n

Upper Darby, Pa.

QUARTERLY REPORT

FOREST INFLUENCES AND FLOOD CONTROL SURVEYS

April 1, 1953

FLOOD CONTROL SURVEYS

by Donald E. Whelan

STATUS OF FLOOD CONTROL SURVEY REPORTS

Connecticut River.—In Secretary's Office.

Merrimack River.--Step 2 draft in review.

Salt River.--Step 8 draft submitted to Washington Office.

Allegheny River, Upper Susquehanna River, and Monongahela River.—No progress.

NE-NYIAC--Resources Survey.—Basin reports in process.

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In the last quarterly report the Forest Influences Division of the Rocky Mountain Forest and Range Experiment Station discussed their efforts to establish the significance of grazing treatments on infiltration.

The Division has made two approaches to the problem: one, comparison of f_c values; and second, statistical analysis of related variables. Dissatisfaction was implied in both approaches since f_c in some cases was higher for poor grazing treatments than for good grazing treatments, and since the statistical analysis indicated "that the poorer the vegetation, the higher the infiltration rate (f_c)."

In hydrology it seems that there is always some inherent difficulty in obtaining one variable that can be used as a basis of comparison for all conditions. In comparing storms for instance, many attempts have been made to relate the maximum rainfall intensity for periods varying from 5 minutes to 24 hours to the peak flood flow. There is usually some degree of correlation with the results generally improved as the drainage area considered becomes smaller. Some of the other variables that make this comparison difficult are as follows: total storm rainfall; the regimen of distribution of rainfall intensities throughout the storm period; soil-moisture content at the beginning of the storm; values of detention and retention storage and percolation rate of the soil horizons; soil-cover complexes; and the components of the peak flood flow--surface, subsurface, and ground-water runoff.

In comparing grazing treatments on the same soil-cover complex it seems important to me to remember that our direct objective is what will be the variation in the volume and time distribution of surface runoff between grazing treatments for a range of storms. One question is that, if f_c for several grazing treatments is applied to the storm rainfall, will the comparison of the respective volumes of surface runoff be satisfactory, especially in view of the variables discussed in the above paragraph. Another one of our inherent difficulties is that surface runoff is computed as a residual--the difference in rates of precipitation and infiltration against time--so that it is not a direct function of infiltration rate.

The question was raised what does f_c mean physically. In a soil moisture study on the Allegheny watershed, Trimble took two undisturbed soil samples of the "C" horizon in nearly 300 plots covering a wide range of forest and open land soil-cover complexes. He found that the detention and retention storage and percolation rate for the "C" horizon did not vary significantly by cover complexes. It could be interpreted from these data that the f_c of any soil-cover complex would be identical with percolation rate of the "C" horizon or parent material for that basic soil group. The f_c could be expected, however, to be higher than the percolation rate to the extent of the rate of lateral or subsurface flow.

We have found in our area that usually about 85% of the roots are located in the first 18 inches of the soil profile. If there is significant root activity in the "C" horizon or parent material, it could be expected that the f_c would be correspondingly higher.

I notice that the depth of soil moisture penetration is also measured according to Station Paper No. 9 "Design and Operation of Rocky Mountain Infiltrometer" by E. J. Dortignac. The validity of the above discussion can be determined by measuring the lateral and vertical penetration of the simulated rainfall into the mass of the soil profile. By taking undisturbed soil samples by horizons outside the infiltrometer area before the run and after the run within the lateral area of penetration, the disposition of the rainfall in the soil mass can then be approximated.

By routing the rainfall through the soil horizons with their detention and retention storage and percolation rate values, it should be possible to reproduce the infiltration curve as obtained from the infiltrometer run. From such a study one would gain a real understanding of what f_c represents.

In our work we have found that land-use management has its greatest influence on the surface soil horizon and that it decreases as the soil depth increases. The increase in the soil detention and retention storage and percolation rate of the upper soil horizons permit more water to be held in temporary storage during rainfall bursts so that there is greater opportunity to utilize the storage in the parent material and for water to flow laterally. We found that by routing rainfall for a specific storm through the soil profile for each soil-cover complex we could obtain the respective total amount of infiltrated water in each case. We then determined what constant infiltration rate applied to the storm rainfall would produce the volume of surface runoff for each soil-cover complex--the difference between the total storm rainfall and the total infiltrated water. If this process is followed through for a range of grazing treatments, the resulting equivalent infiltration rate should form an adequate basis for comparing effectiveness of grazing treatments on infiltration.

FOREST INFLUENCES

DELAWARE BASIN RESEARCH CENTER
by the Delaware Basin Staff

Rain and Snow

For the third straight year, a high level of precipitation is being recorded at Dilldown Watershed. It now appears likely that our original estimate of normal precipitation for the watershed was too low and that the high yearly totals for the past two years were not as much above normal as we previously believed.

Our original estimate was taken from a small scale isohyetal map showing the average rainfall for this part of the State. Published precipitation records for nearby stations are incomplete and cannot be used for comparison with any confidence. It is quite likely that the particular topography in the vicinity of Dilldown causes a local rainfall pattern different than that for the Pocono Plateau as a whole.

The possibility is strengthened by comparison of rainfall rates between the Dilldown Watershed and the Pocono Experimental Forest. Although the two areas are of practically the same elevation and the airline distance between them is only 16 miles, annual rainfall at the Pocono Experimental Forest has been consistently about 20 percent less than that at the Dilldown Watershed for the period of measurement.

The following tabulation compares the records for the two areas:

	Precipitation - Inches Hydrologic Year			
	1949-50	1950-51	1951-52	1952-53
Five-month totals Oct. 1 to Feb. 28				
Dilldown	17.88	28.33	26.90	27.88
Pocono	14.67	23.83	20.68	21.26
Yearly totals Oct. 1 to Sept. 30				
Dilldown	45.08	59.94	75.88	--
Pocono	37.31	50.21	59.39	--

Snowfall and snow storage were very low at the Dilldown Watershed during the past winter. The deepest snowfall was about eight inches early in January. Most of this melted in the following two weeks and was entirely gone by the beginning of February. Two other measurable snowfalls, one each in December and February, lasted only a few days.

The open condition of the winter was also reflected in the slight amount of soil freezing as compared to frost depths of other winters. Frost measurements continued from the middle of December to the end of March. At no measurement was over four inches of frost found and this was granular frost. No concrete frost entered the minersal soil throughout the winter.

Temperature

Several years ago we noticed the minimum thermometers at our weather stations generally were registering a lower temperature for the current reading than were the maximum thermometers. If both thermometers were exact, they would register the same temperature at the time of measurement.

Since then, the weather observers at the Delaware-Lehigh and Pocono Experimental Forests have been recording the readings of both thermometers taken simultaneously.

Recent analysis shows that the minimum thermometer is almost invariably lower than the maximum thermometer and that the differences grow progressively larger with time, becoming as great as three degrees.

A mercurial thermometer such as the maximum thermometer is considered much more exact than a minimum thermometer which contains alcohol. The alcohol is a highly volatile fluid; in time part of the main column will distill off and condense at the top of the tube. As the minimum thermometer is never exposed in an upright position, the main column gradually decreases in size and thereby registers gradually decreasing readings.

The effect of this condition is the registering of minimum temperatures lower than actual and may give a misleading picture of the climate in the vicinity of the weather station.

Fortunately, we have the simultaneous readings and are able to determine correction factors to apply to our recorded minimum temperatures. However, considerable time was spent during the quarter making these corrections in preparation for publication of weather data at the Delaware-Lehigh Experimental Forest.

It is believed this job may be eliminated in the future by a periodic rotation of minimum thermometers. The accuracy of a minimum thermometer may be restored by joining the entrapped fluid to the main column. This is a delicate procedure in which hot water is used carefully to drive up the main column until it touches the entrapped fluid. The thermometer is then hung in an upright position for a number of days to allow the fluid to drain off the sides of the capillary tube into the main column.

Following this procedure, the minimum thermometer will read very close to the maximum thermometer and no correction will be necessary. We shall continue to record both temperatures as a check. When the differences begin to average more than 0.5 degree, the thermometer will be removed for adjustment and a recently-adjusted thermometer will be installed.

Meetings

Don Whelan (Flood Control) and Bethlahmy attended the Tenth Annual Eastern Snow Conference. Easterners are becoming increasingly aware of the importance of water, snow, and ice. Since the end of the war, the number of representatives attending the conferences has increased annually. Generally, both government and industry are well represented. Of special interest this year was the large number of Canadian representatives.

In our last quarterly report, we reported on the damage done in the City of Bethlehem watershed. Since that time, Reigner and Bethlahmy, with Frantz (of INCODEL), inspected the watershed together with the Mayor and his council. Remedial measures were outlined. Since the problem has now attracted the attention of the chief city officials, perhaps corrective measures will soon be instituted.

MOUNTAIN STATE RESEARCH CENTER

by the Staff

GENERAL

Calibration of the five watersheds on the Fernow Experimental Forest is continuing. Two growing periods and one dormant period have passed since the initiation of the study. Aside from maintaining these calibrations, our main efforts during the past two years have been concentrated on studies of road erosion. These studies will be intensified during the coming year.

SKID ROAD EROSION

We have been making a study of the factors involved in skid road erosion and attempting to define remedial or alleviating measures. The first results from these studies have been presented in two papers: "Skid Road Erosion Can Be Reduced" Weitzman and Trimble, Journal Soil and Water Conservation, July 1952; and "Soil Erosion on Skid Roads" Trimble and Weitzman, paper presented at the annual national meeting of the Soil Science Society of America in Cincinnati, Ohio, November 1952.

KRILIUM

Work has been started to determine the effect of Krilium in controlling post-logging skid road erosion. The study is being made on four sections of skid road; two with grades of 27 percent, and two with grades of 36 to 42 percent. One section in each grade class has been treated; the duplicate sections are controls. Each section is 120 feet long and separated from the rest of the road by water bars. All sections were subjected to the same heavy usage during skidding.

Krilium was applied at the rate of approximately 400 pounds per acre. It was applied in mixture with inert clay in the ratio of 3 parts clay to 1 part Krilium. Frequent erosion measurements will be made to determine soil loss from the sections. In addition, detailed observations will be made of natural revegetation on each section.

SKID ROAD REVEGETATION STUDY

It is known that vegetation reduces erosion. The purpose of this study is to determine if a vegetative cover can be established on skid roads through the use of chaff from local sources. The chaff contains wheat, oat, and weed seeds.

Specifically the objectives are:

1. To determine if the seeds in the chaff will germinate and thrive on bulldozed and compacted skid roads under each of the following conditions:

   A. Broadcast seeding--no mechanical disturbance--no fertilizer or lime.

   B. Broadcast seeding--mechanical disturbance--no fertilizer or lime.

   C. Broadcast seeding--mechanical disturbance--fertilizer and lime.

   D. Broadcast seeding--no mechanical disturbance--fertilizer and lime.

   E. No treatment--control.

2. To determine the differences between treatments and to evaluate which treatments result in successful vegetation.

Soils data will be collected from the test area before treatment. Seeding will be done during March 1953.

The experimental design will take the form of a latin square.

TRUCK ROAD EROSION

On the Monongahela National Forest, a set of standards for constructing and maintaining logging roads have recently been developed. These standards are based on the best information available in respect to width, grade, and maintenance. However, there is no evidence to show that these roads are or are not adequate to protect soil and water values. A study is being initiated on the Fernow Experimental Forest where two roads have been built to these standards, to test their effectiveness in erosion control.

The specific objectives of this study are:

1. Relate the rate of erosion on a truck road built to Monongahela standards to:

   A. Grade

   B. Distance between road surface drainage structures. Adjustments in these standards can be made in accordance with the findings of this study.

2. Determine the effectiveness of after-logging treatment in reducing erosion and relate this reduction to:

   A. Grade

   B. Distance between surface drainage outlets.

Two types of treatment will be tested on these roads after the logging operation is over and the roads are put to bed:

1. Seeding to Lespedeza sericea.

2. Brushing with hardwood tops and limbs from the logging operation.

SEDIMENTATION STUDY

In connection with the erosion study on truck roads, a sedimentation study is being made on the stream draining the hollow up which one of these truck roads was built. The purpose of this study is to evaluate and demonstrate the effect of building a road to Monongahela standards up a typical forested watershed. It will, to some extent, serve as a partial test of these Monongahela road standards.

Water samples were collected from the test watershed and a control (undisturbed) watershed before and during construction and are being collected after construction. Sampling procedure is designed to sample all water level stages occurring in any period; i.e. before, during, and after construction, and during and after logging. In addition to sampling by stages intense sampling is done during and immediately after heavy rains.

EFFECT OF A FOREST CANOPY ON GROUND RAINFALL INTENSITIES

A study to determine the effect of a fully stocked hardwood forest canopy on ground rainfall intensities, and incidentally, throughfall, has been completed. A manuscript entitled "The Effect of a Hardwood Forest Canopy on Rainfall Intensities" has been written and is now being processed for submission to a suitable periodical.

This study was begun in the summer of 1951 and carried well into the summer of 1952. It was discontinued during the spring and fall when the trees were in a stage of transformation from bare to leaf and vice versa. Five recording rain gages were placed at random in an area of 50-year old hardwoods. Elevation, aspect, and slope position were similar for all gages. The control consisted of a recording gage in a one-half acre cleared plot within 150 yards of any canopy gage and similarly located with respect to elevation, aspect, and slope position.

Three comparisons were made between the measurements recorded at the open and canopy gages:

(1) Maximum 5-minute intensities

(2) Maximum 15-minute intensities

(3) Throughfall.

The results of these comparisons were computed separately for summer and winter conditions and are summarized below:

1. The differences in intensities and throughfall between the open and the average of the canopy gages were highly significant at the one percent level in all cases.

2. Linear regression equations were determined to enable estimation of intensities and throughfall under a canopy from measurement of rainfall in the open. They are as follows:

Summer

Max. 5-minute intensities - $\hat{Y} = 0.97584X - 0.07728$

Max. 15-minute intensities - $\hat{Y} = 0.94766X - 0.06106$

Throughfall - $\hat{Y} = 0.80918X - 0.01636$

Winter

Max. 5-minute intensities - $\hat{Y} = 0.85238X - 0.01184$

Max. 15-minute intensities - $\hat{Y} = 0.80715X + 0.00674$

Throughfall - $\hat{Y} = 0.78911X - 0.00618$

Examination of these equations leads to several important observations:

A. High intensity rainfall is but little reduced by the tree canopy in either summer or winter. However, these high intensities are reduced more by the bare crown in winter than by the leafy crown in summer. For example, the winter canopy reduces a 5-minute maximum open intensity of 3.00 inches per hour by .45 of an inch or to 2.55 inches. The summer canopy reduces this same open intensity only to 2.85 inches. This difference is significant.

B. The lower the rainfall intensity, either in summer or winter, the greater is the relative reduction by canopy.

C. The effect of canopy in reducing given intensities increases slightly with an increase in the length of the period of measurement--at least as between 5 minutes and 15 minutes. As illustration, given a summer intensity of 3.00 inches per hour for a 5-minute period, the reduction by canopy is .15 of an inch. Given the same intensity for a 15-minute period the reduction is .22 of an inch. The same trend holds true for winter conditions.

D. Throughfall is reduced by canopy interception approximately the same amount in both summer and winter.

E. For throughfall, as for most intensities, the relative effect of canopy varies inversely with the size of "X".

F. Coefficients of variation for canopy gage averages indicate greater variation beneath a summer canopy than beneath a winter canopy for both intensities and throughfall. The coefficients of variation also indicate that variations tend to be greater for storms of low total precipitation than for large storms.

G. In the case of every canopy gage, both summer and winter, individual gage averages for the period were less than the open average and closer to the canopy average than to the open average.